# Musings of an Armchair Philosopher[1]

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The eminent botanist, Dr. J. Arthur Harris, speaking before a group of graduate students in science, brought forth the extremely challenging idea that in any science as it expands, the real advances being made are those which are out on the border where they either impinge on one of the other sciences or where they are at the point of developing a new science entirely different from any we know at present. This conception is something for us as entomologists to consider seriously in relation to our own field because too often we are inclined to dig ourselves down in the center of our own specialization of taxonomy, physiology, insecticidal chemistry, biological control, or what you will, rather than training our thoughts out at the borders where the advances can be made. True enough, it is of interest and value to continue with the description of new species until we have exhausted all the faunal possibilities of a region, to study the morphology until we have pictured and described all of the physical features of the beast, or to determine the physical and chemical constants of an insecticidal oil until we have them all in their proper categories determined to the fourth decimal place; but in so doing we are perhaps more likened to the cataloger or compiler rather than to the productive and independent research worker. One characteristic of the majority of workers in any science is that they tend to work their way toward the interior regions of their chosen field where many have already passed over, instead of being at the frontier. The student preparing his mind for work in science is privileged to prowl through the regions where others have already done the fundamental work, but those who profess to be active workers in research must not retain the qualities of the infantile mind but must be out where the trails are absent or few. It is there that the new developments will occur.

It is, of course, out of the question for us to explore in the time allotted to us today the complete fringe of our own chosen field of entomology even as it presents itself to us here in these islands. Realizing this I shall only attempt to indicate some of the paths that run out to the wilderness of the unknown.

## BIOLOGICAL CONTROL

Since we in Hawaii have among our membership some of the pioneers in the field of the biological control of insects, it is fitting

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that we first consider where the borders lie and where we may expect to find advances.

There has grown up in recent years a new conception of insects in their relation to their environment. This is commonly expressed in the form of the populations. The earlier attempts, such as those of Thompson, had in mind primarily the prediction of the time it would require for an insect to be overcome by an introduced enemy. As we look at his work now we realize that his was a purely hypothetical example which took into account neither the complexity of factors surrounding the host insect and its enemies nor the fact that insect populations do not conform to the peculiar conditions he presumed for the growth of populations. The important thing about his work was that he set to work on a new idea which promises to bear fruit for us in the future. His work, using the tool of mathematics, was followed by that of others—Chapman, Volterra, H. S. Smith, and other men who at this time comprise a considerable list. How useful it would be if when out on an exploration for natural enemies we could establish ourselves in a laboratory, once we had encountered possible useful natural enemies, determine certain characteristics of these animals and determine in advance what the result would be if they were released in our fields. No doubt this idea seems a bit fantastic but no more so than that of the group of chemists who followed Mendeleef, who predicted not only the existence of certain then unknown elements but calculated what the characteristics of these unknown elements would be if they should ever be encountered.

Our present methods, whereby we import parasites and release them blindly in the hope that they will alter the level of the insect pest, will probably be looked on in the future as the utmost in naïveté. What do we know concerning the ramifications which may result from the bringing into our islands of certain predacious forms? We can say that in general we are probably fairly secure, but we really know nothing concerning the interrelating results to be expected when we upset one balance in nature to bring it to a new level. Compensating forces will operate to bring new balances into operation but we cannot predict with any degree of certainty what they will be. It is not impossible to conceive of such a chain of events taking place as that of introducing *Bufo* to control *Anomala*. *Bufo,* however, is responsible for killing the mongoose which keeps down rats to a certain degree. With the rat population rising we could also expect an increase of fleas. More fleas would mean a greater incidence of plague in rats. More rat plague would increase the danger to humans with the possibility of an epidemic of plague in humans. The above sequence did not occur but it points out how little we know of such biological sequences. Not even enough to serve as a basis for generalization, much less to be of practical use in introduction work.

## TAXONOMY

The field of taxonomy has been built up on the conception that description of insects must be based on morphological characters. The system of classification is useful and workable but it does have the serious handicap of having become unwieldy and extremely complicated; and in the last analysis many species depend for their identification on the opinion of the individual taxonomist. Likewise, our system of naming has become ponderous, as it must where morphological characters are the basis of classification. There is no question but that a decimal system might be arrived at which could be extremely workable and simpler. Perhaps some bright young entomologist may some day arrive at a means of making determinations of species on the basis of spectrographic analysis of the specimen which might lend itself to a scheme which though it would throw our present classification entirely into obsolescence, would be so entirely suitable that it would replace to a high degree the cumbersome system we are now using. At present it seems difficult to conceive of the usage of such a combination as 27:346:11:x to represent *Pseudococcus brevipes,* and the description being based on combinations of absorption lines in a spectrum; but while it is fantastic, so was the telephone until it was developed to the point where it was workable and adaptable to human use.

With the numbers of species of insects continually growing and our literature bulging with descriptions, there must come a time when changes will be made in classification systems. It may be that my suggestion above will prove ridiculous, but simplicity will certainly come and it will come along new fundamental principles when it does appear. It is not too soon to be searching for these principles.

## SUSCEPTIBILITY

Any agriculturist knows that when he walks through a field bearing an insect infestation certain plants will be entirely free from damage. He knows too, that if he selects the progeny of those plants the succeeding generation will still show approximately the same degree of damage since what appears to be resistance is really only a degree of individual susceptibility. In the case of mealybug wilt of pineapple such is certainly the case and we can only presume that there is a deficiency in the soil at the particular spot where the diseased plant is growing which enables the disease to make its appearance on certain plants and to be masked in others. The problem is one that is certainly on the borderline of entomology. We know the insect and its habits and characteristics well enough but the solution of the problem does not lie in that direction. Research must go in the direction of plant physiology and particularly in the method in which the plants utilize mineral nutrients. In the plants which do not wilt certain physiological balances must exist which neutralize the effects of the toxin of the mealybug. May we not visualize the same method for approach of other problems involving sucking insects? It may well be that the day will come when the chemist will be considering not methods whereby he may kill the pest but rather means of modifying the soil and thus the physiology of the plant so that it becomes tolerant of the presence of the insect.

### INTERNAL THERAPY OF PLANTS

Along similar lines as the preceding and a question that likewise borders on physiology is the question of the possibility of injecting materials into the plant which will be absorbed and be either toxic to the insect or will render the plant immune to attack. Certain rather crude experiments have been performed whereby plants have been rendered immune to attack by aphids through injection of certain materials into the conducting system of the plant. The success by which certain diseases of man and animals have been treated by the use of injection of complex compounds into the circulatory system suggests that a whole new field is open here for investigation. There are, without doubt, compounds which plants can tolerate which would confer immunity to insect attack; but advance has been slow, primarily because methods for bringing such treatment about are still very crude. We may yet see the day when the "tree doctor" carries a hypodermic syringe with him as an indispensable part of his equipment.

### INSECTICIDES

The field of insecticidal chemistry is one in which advance is being rapidly made at the present time. This is attested to in the fact that in browsing through literature one finds a whole host of materials, of which he has only vague recollections from his courses in chemistry, being tried and in some cases actually put into application on a commercial scale. It is true that the present cost of some of these materials makes their use prohibitive. However, cost alone cannot be considered to be the sole governing factor for the entomologist to consider where he is investigating chemical materials for their toxic properties. Any insecticide is cheap or costly only in relation to the value of the crop which it is designated to protect. If it so happens that it costs thirty dollars per acre and yet increases the yield for a given field to twice that amount it is still a cheap and entirely feasible material to use commercially. Much still remains to be known concerning the toxic fractions of the insecticides which we are commonly using. In the insecticidal oil now in use we are probably paying a considerable sum for material which in no way is related to the toxicity of the material, simply because the toxic elements are found in a rather expensive carrier. If we could determine what those elements are it might be entirely possible to synthesize them at a cost much below that which we pay at present and combine them with water; and in so doing not only reduce the costs but also have the material in a much more convenient form.

## HOST SEQUENCES

The subject of host sequences is one that is virtually untouched and yet there is much of value hidden in such information. Carter showed the way for this line of research when he found that there was a relation between the symbionts of mealybugs and their ability to produce green spots on pineapple; and moreover that the symbiont complex of the mealybug could be altered dependent on the host plant on which the insect had last fed. It is very likely that there are other cases where the toxicity of the insect to the plant is correlated with its internal fauna affecting its secretions and there is even the possibility of utilizing this principle in reducing the damage from those insects. If, for instance, it were found that the toxic element could be removed by host transfers, this could be done on a field scale by growing, during the intercycle period, between the main crops, certain plants having this characteristic, and forcing the pest to lose its toxic principle. Save, perhaps, for certain instances among the aphids where there is some information regarding host sequences and their effects, the field is one in which virtually nothing of a precise nature is known. The idea is new but information permitting its use as a control principle is neither available nor apparently forthcoming, for the present at least.

## HOST AVOIDANCE AND SELECTION

It is well known that insects show certain characteristics in their selection of hosts. Some of them are almost specific in that they must not only have a certain variety of host species but they are limited to definite portions of the host and cannot survive on other portions. In contrast to this there are the cases of completely omnivorous insects which show few if any indications of being particularly selective in their choice of food materials. The factors here involved are but poorly known. In most cases this is thought to be related either to the sense of taste or smell of the insect but in observing the precise way in which the characteristic operates, it no doubt is also relayed to the entire psychological make-up of the animal. Research along this line has not shown too much of value for practical application. The chemistry involved is both delicate and difficult but in many cases it is certain that some slight alteration in the substrate to which the insect is exposed on the plant would be all that would be necessary to mask the material that is responsible for the insect's choosing it as a favorable host plant. It is certainly not a far-fetched approach but yet is one that should yield valuable information to the research worker if it could be determined what the general principles are that are responsible for host selection or avoidance.